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AFFECTIVITY OF CHEMICAL WEED CONTROL IN COMMERCIAL TEA PLANTATIONS: A CASE STUDY IN HAPUGASTENNE ESTATE, MASKELIYA, SRI LANKA

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Abstract

The usage of agro chemicals on food crops is getting restricted day by day with the sanctions set by the institutes devoted in food security, mainly due to the disclosure of their harmful residual effects on human health. Thus, several Commercial Tea Plantation companies have voluntarily suspended the use of many Herbicides on Tea under their charge, which are still permitted to use in Sri Lanka. Intense emergence of Herbicide tolerant weed species on treated areas was noted in the mean time, although this crucial factor had been remained un-noticed as a result of frequent manual weeding under taken by the Tea estates under various other accounts such as plucking, fertilizer application, mossing and ferning green manure etc. Therefore, an investigation was carried out to ascertain the affectivity of Herbicides recommended for Commercial Tea Plantations, over a period of 24 months in Hapugastenne Tea Garden, Maskeliya, since year 2012 at five different elevations, with five replicates set at each elevation. Results show that over 20 weed species out of 23 acutely problematic weeds which cause great damage to Tea crop, are entirely tolerant to Diurone, Paraquat and Glyphosate and cannot be controlled by using said Herbicides. It was further revealed that such weed species have the ability to turn a Tea Plantation into a totally unproductive and economically non-viable unit within a time period of one to two years depending on the herbicide tolerant weed species present. These weeds are capable of suppressing the growth of the Tea bushes by making them stunted in growth with poor bush frames, turn the foliage yellowish and induce defoliation, unless they were removed completely by manual uprooting.

Keywords: **Food security; Herbicide tolerant weeds; Manual weeding; Commercial Tea Plantations.**

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1. Introduction:

The usage of agro chemicals on food crops is getting restricted day by day with the injunctions set by the international organizations, governments, food product dealers and consumer organizations etc., mainly due to the disclosure of their harmful residual effects on human health. Accordingly, the usage of many *Herbicide* chemicals on Commercial Tea plantations had to be voluntarily discontinued within the past decade in Sri Lanka, owing to the vetoes imposed by Tea buyers led with various international food product and process certifying authorities, although some of those agro chemicals are not banned in the Island by the state government. Suspension of the use of MCPA and 2.4.D (*Propanil*) in Tea Gardens by several Regional Plantation Companies (RPCs) on their own accord in the recent years is a good example to this effect. Hence the real affectivity of permitted *Weedicides* recommended for weed control in Commercial Tea Plantations has become greatly questionable due to the intense emergence of Herbicide tolerant weed species on treated areas causing persistent economic crop loss. (Syngenta.2015). However this crucial factor had been deeply masked and remained un-noticed as a result of frequent manual weeding under taken by the Tea estates whilst plucking and some other field operations as well. Therefore, a considerable fraction of the true cost of effective weed control in Commercial Tea too, partially hidden in the expenditure incur in other field operations carried out in plantations, such as plucking, mossing and ferning, fertilizer application, and green manure etc., undertaken outside the budgeted allocation for weeding.

Methodology:

Therefore a study was launched in year 2012 in Hapugastenne Tea Garden, Maskeliya, to determine the affectivity of permitted Herbicides recommended for Commercial Tea Plantations at the time, using *Diuron, Paraquat* and *Glyphosate*. This experiment was designed to ascertain the sole affectivity of chemical Herbicides in controlling the natural regeneration of floral species on Commercial Tea Plantation soils. Randomly selected 03m X 03m experimental plots in clusters of five replicates were established in five different elevation ranges. That is, ***A)*** 850 m to 900 m, ***B)***1000 m to 1030m, ***C)***1120 m to 1150m, ***D)***1210 m to 1240m and, ***E)***1360m to 1400m above *average mean sea level* (amsl). The study commenced following pruning and a thorough Mossing & Ferning, also coupled with a complete manual removal of all chemical resistant weeds from the ground. The entire land extent under the experiment including the experimental plots, were periodically treated alike, exclusively with Glyphosate 36% (2.0 l ha^{-1}), Paraquat 6.5% (3.3 l ha^{-1}) and Diuron 80% (1.2kg ha^{-1}) in 480 l of water ha^{-1} (TRI 2012) over a period of two years in Vegetatively Propagated Tea (VPT) fields aged between 15 to 40 years, adhering to Tea Research Institute (TRI) recommended dosages. Type of herbicide/s, were chosen based on the variety and stage of weed growth. Usual manual weeding carried out following the applications of Herbicides, to remove remaining weeds unaffected, (Bhowmic,1997) was considered as the experimental treatment. Thus the demarcated field plots were taken as the control plots. Manual and mechanical weeding was completely arrested in the control plots declared. Both experimental and control areas were sprayed alike, during herbicide applications. Whereas, chemical resistant weeds remained and grown in tea extent outside the control plots, were removed by frequent manual uprooting. (Nathaniel,

1982) The initial readings were taken in control plots after five to six months from the commencement of the study, following two repeated periodic herbicide applications, preferably after 30 days from the second herbicide application. However, none of the herbicide tolerant weeds were removed from the control plots and allowed to grow up to 12 months. Data was collected paying special attention to species diversity of Herbicide tolerant major weeds and their species density. Data were analyzed using Turkey multiple mean comparison test.

Results, Discussion, Conclusion and Recommendations:

The major weed species counts recorded in control plots against the varying elevation were almost alike, but the species composition of weed community on ground and their numbers varied ($p>0.05$) significantly over time. Two herbicide resistant weed species namely *Hedyotis neesiana* (Getakola) plantlets and *Crassocephalus crepidioides* (Thandam pullu) showed a marked dominance in all control plots maintaining a grand averages of 77 plants per m^2 and 37 plants per m^2 respectively, after 05 months from the commencement, covering around 15% of the ground area. Next most abundant weed species recorded was *Commelina benghalensis* (Amalai). Surprisingly no *Clidemia hirta* (Karuppati Chedy) plants were noticed, on ground at this stage of the study. At 12-15 months and after about five consecutive rounds of herbicide applications, *Hedyotis neesiana* showed a clear dominance at the ground level, forming a 15-20 cm thick mat over the ground. The species density had declined to 32 plants m^{-2} from the initial count of 77 plants m^{-2}. Herbicide tolerant weed species *Clidemia hirta* in the mean time, had increased the population and managed to establish a species density of 36 plants m^{-2}, from the zero level reading at six months. These plants were mostly single-stemmed and remained below plucking table at this stage. *Commelina bengalensis* recorded a species density of 2 plants m^{-2} at ground level as scattered patches and also as a mix with *Hedyotis neesiana*. Initial dominance displayed by *Crassocephalus crepidioides* with a high figure of 37 plants m^{-2} had been reduced to comparatively lower figure of 1.4 plants m^{-2} in presence of *Hedyotis neesian* and *Clidemia hirta* by the way, yet the species profusely emerged above the tea canopy. Herbicide tolerant climber weeds namely *Ipomoea learii* (Paal Kody), *Mikania scandens* (Thanni Kody) too exhibited their ability of reaching tea canopy and conceal same in no time, suppressing the growth of the tea bushes wherever they were present despite very low species densities recorded. Occasional emergence of notorious *Austroeupatorium inulifolium* (Kurunjang Chedy) and herbicide resistant grass *Panicum maximum* with low species densities too were recorded at this phase of the investigation. Observations were much more interesting at the bench mark of 24 months from the launch of survey, following eight repeated applications of weedicide chemicals. Early dominance shown by *Hedyotis neesiana* was markedly over taken by *Clidemia hirta* at this stage of the survey. Further it was noted that the climber weeds, specifically *Ipomea learii* and *Mikania scandens* were even capable of suppressing *Clidemia hirta* at canopy level other than tea bushes, and completely retard the growth of both crop and the weed bush types. Weedicide tolerant plant species such as *Crassocephalus crepidioides, Erigeron sumatrensis, Austroeupatorium inulifolium, Panicum maximum,* and fern weeds however, displayed their ability in penetrating the thicket and also the overlying carpet established by the climber weeds and emerging over the plucking table. Therefore, the tea bushes in control plots were exhibiting symptoms of extreme stress. They were either stunted in their growth with yellowish foliage,

defoliated and also with poor bush frames where the areas infested by *Clidemia hirta*, or completely covered by where *Ipomoea learii* and *Mikania scandens* climbers were present. Results show that many acutely problematic weeds, which cause great damage to tea crop in commercial tea plantations are entirely tolerant to Diurone, Paraquat and Glyphosate and cannot be controlled by using said herbicides.

Table 01: ***Population density variation in Herbicide tolerant weed species in Commercial Tea.upto 24 monthsfrom (mossing &ferning) followed pruning. (Units;#plants/m^2)***

WEED SPECIES	06 months	12 months	24 months
CLIMBERS/RUNNERS			
Mikenia scandens	**0**	**1**	**1**
Ipomea learii	**0**	**2**	**1**
Hedyotis neesiana	**77**	**37**	**2**
Commelina benghalensis	**01**	**1**	**1**
Andredera caudifolia	0	0	1
Centella asiatica	0	2	8
SHRUBS/HERBAL BUSHES			
Clidemia hirta	**0**	**37**	**3**
Crassocephalus crepidioides	**38**	**6**	**1**
Austroeuphatorium inulifolium	0	0	1
Exallage auricularia	0	13	7
Erigeron sumatrensis	0	1	1
Borreria hispida	0	2	1
Panicum maximum	0	0	1
Elusine indica	0	1	0
Nephrolepis exeltata	0	0	3

Note: bold lettered species causing economic damage in mature Tea.

These weed species have the ability to turn a tea plantation into a totally unproductive and economically non-viable unit within a time period of one to two years depending on the types of herbicide tolerant weed species present. Such weeds are capable of suppressing the growth of the tea bushes by making them stunted in growth with poor bush frames, making the foliage yellowish and inducing defoliation, unless removed completely by manual uprooting.

Therefore, the results clearly reveal that the herbicides used in commercial tea plantations are greatly ineffective in weed control and their use cannot be justified when considering the associated cost involved along with the health hazards, ecological and environmental issues forged against them are considered.

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